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Efficiency and Productivity Analyses of Indonesian Manufacturing Industries

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Abstract

This study estimates the technical efficiencies and total factor productivity (TFP) growth in food, textile, chemical and metal products industries during 1993 to 2000 in Indonesia by using the stochastic frontier model. Furthermore, the determinants of inefficiency are also analyzed and the TFP growth is decomposed into technological progress, scale component, and efficiency growth. The results reveal that the food, textile, chemical and metal products sectors are on average 50.79%, 47.89%, 68.65% and 68.91% technically efficient respectively. It is noted that ownership contributed to technical inefficiency in the food sector; location and size contributed to technical inefficiency in the textile sector, whereas size, ownership and age contributed to inefficiencies in the chemical and metal products sectors. The estimates of TFP growth indicate that productivity in Indonesian manufacturing industries decreased at the rate of 2.73%, 0.26%, 1.65% and 0.5% in food, textile, and metal products respectively, whereas in the chemical sector, it increased at a rate of 0.5% during the period of the study. The decomposition of TFP growth indicates that the growths are driven positively by technical efficiency changes and negatively by technological progress in all four sectors.

JEL Classification: D24, C23, O14.
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1. Introduction

In their path breaking articles, Aigner, Lovell, and Schmidt (1977) and Meeusen and van den Broeck (1977) introduced the use of stochastic frontier model to estimate technical efficiency in manufacturing firms. The former used the US primary metals industry data for 1957 and 1958 while the later utilized 1962 French Census of Manufacturing data. Since then many authors e.g., Pitt and Lee (1981), Battese and Coelli (1988) and Kumbhakar (1990) extended their analysis to the panel data. The application of stochastic frontier models has also spread from manufacturing to other sectors, e.g., agriculture, financial and other services. Empirical application on manufacturing has been done by Marcos and Galvez (2000) who studied technical efficiency of Spanish manufacturing firms during the period 1990 to 1994. Mahadevan (2000) estimated technical efficiency for 28 Singapore's industries during 1975 to 1994. Mini and Rodriguez (2000) estimated Philippine manufacturing firms in 1994. The relationship between the firm’s efficiency its size and age was studied by Lundvall and Battese (2000) for Kenyan manufacturing industry and noted that the relationship between efficiency and firm age is not significant. More recently, Kaynak and Pagan (2003) estimated technical efficiency for U.S. manufacturing industries, Kim (2003) estimated sources of efficiency in Korean manufacturing industry and Wadud (2004) studied efficiency in Australian textile and clothing firms.

There are several studies related to Indonesian manufacturing efficiency. Pitt and Lee (1981) used pooled data on fifty Indonesian weaving industries for the years 1972, 1973 and 1975. Based on time variant and time invariant stochastic frontier analyses their estimates of average efficiency ranged between 60% and 70%. In the garment industry in Indonesia. Hill and Kalirajan (1993) noted that the average efficiency of small firms was 62.6%. Only 7 firms were more than 85% efficient, and 542 firms were less than 50% efficient. In the medium and large garment firms, Battese, Rao and Walujadi (2001) reported technical efficiency to be around 66% during 1990 to 1995 for all regions. However, they also reported that the lowest technical efficiency was 48.5% for Jakarta and the highest was 83.7% for East Java.

Beside efficiency, productivity is another issue that has been widely discussed in Asian countries. Estimating total productivity growth can be done through several approaches, such as neo-classical approach and decomposing approach. In the neo-classical approach, productivity growth, know as TFP growth, reflects all the effect of output growth that cannot be ascribed to the inputs in production, whereas in decomposition approach, TFP growth is broken down into technological progress, scale component and the technical efficiency changes. Empirical studies on total factor productivity growth for Asian countries have been investigated by many authors. At firm's level, such studies include Kim and Han (2001) who estimated TFP growth of Korean manufacturing industries by using decomposition method. Oguchi, Amdzah, Zainon, Abidin, and Shafii (2002) who studied TFP growth using growth accounting method for Malaysian manufacturing industries. Using the same method, Koh, Rahman and Tan (2002) estimated TFP growth for Singaporean manufacturing industries, whereas Mahadevan (2002) used TFP decomposition method to investigate productivity growth for most service sectors in the same country.

There have been some studies on estimation of TFP growth of Indonesian manufacturing industries. Using growth accounting method, Timmer (1999) utilized panel data of Indonesian manufacturing industries over the period 1975-1995 and concluded that annual TFP growth during this period was 2.8%. Between 1975 and 1981 TFP growth was 1.0%, four years later it decreased to 0.1%, but for the next four years TFP growth increased dramatically to 7.9%. However, during the first half of 1990s the TFP growth declined again, i.e. 2.1% per annum. Overall, his results showed that TFP growth accounted for only 22% of the output growth. Although TFP growth is quite high as compared to Korea and Taiwan, it is still considerably low. Using the same method, Aswicahyono and Hill (2002) also studied TFP growth of Indonesian manufacturing industries. Based on 28 firms over the period 1975-1993, they estimated that during 1976-1981 TFP grew 1.1%, but between 1981-1993 TFP declined and contracted to –4.9% per annum. On average, the TFP growth over the period of study was 2.3%.

Note that the TFP growth estimated by using accounting method includes only the impact of the technological progress and fails to account other factors contributing to the TFP growth. To fill this gap in the literature, this study estimates TFP growth on Indonesian manufacturing industry using the decomposition method, i.e., by decomposing TFP growth into technological progress, scale component and the technical efficiency changes. The advantage of the decomposition method is that it allows not only to estimate the TFP growth, but also identifies the sources of growth. In addition to that, the decomposition method relaxes the assumption that inputs are used efficiently which is more plausible in practical sense. Thus, the objectives of this study are to estimate technical efficiency by using stochastic frontier model for the food, textile, chemical and metal products sectors. Toward his goal the translog production frontier is estimated for these sectors from 1993 to 2000. Moreover, the TFP growth using decomposition method is also estimated. These manufacturing industries are chosen because based on their importance in the Indonesian economy in terms of the contribution of value added to the whole manufacturing sector as discussed in the next section.

The paper is organized as follows. Section 2 briefly discusses Indonesian manufacturing sector. The methodology and data are discussed in Sections 3 and 4. The technical efficiency analysis and the total factor productivity analysis are discussed in Sections 5 and 6. Finally, Section 7 concludes this study.

2. Indonesian Manufacturing Industry

Indonesia, the largest archipelago in the world, is well known for its abundance of natural resources. Since 1980, Indonesia experienced unprecedented rapid economic growth. During 1980-1990, Indonesian economy grew 6.1% per annum and during the next eight years the annual economic growth was at 5.8% per annum (World Bank, 2003). However, the economic and financial crisis that hit Asia in 1997/1998 adversely affected Indonesian economy. In 1998, economic growth declined by more than 13%, but slowly recovered and it reached 3.66% in 2002 (Central Bureau of Statistics, 2003). Like most of the developing countries, in the early stages of development, Indonesia relied upon primary products such as agriculture, forestry, fisheries, and mining, and the role of secondary products such as manufacturing industries was relatively small. For example, in 1960, agriculture sector accounted for 51.5% percent of GDP, while the share of manufacturing industries to GDP was only 9.2% (World Bank, 2003). As the process of development moved forward, the structure of Indonesian economy changed. After agricultural production declined considerably in the beginning of the 1980's, the economy was supported by the oil boom. However, the collapse of oil prices and prices of other raw materials in the mid 1980s forced the government to change economic policies towards manufacturing industries. As a result, starting in the mid 1990s, the manufacturing industries superseded agriculture as the largest contributor to the GDP. In 2002, the share of manufacturing industries to GDP was more than 25%, while agriculture's contribution was only17.47% (Central Bureau of Statistics, 2003).

The remarkable development of Indonesian manufacturing industries for twenty years prior to the financial and economic crisis of 1997/1998 is well documented by Hill (1997) and Dhanani (2000). The government introduced a number of incentives for firms, such as subsidized export credit, duty free import for manufactured export products etc. The manufacturing industries also benefited from bank regulations and from a series of policy reforms in trade, capital market and tax law in the late 1980's (Harris, Schiantarelli and Siregar, 1994). The reforms continued in part, for Indonesian firms to be competitive with other countries. Tariff and non-tariff barriers implemented in the 1970s to protect the domestic industries were removed gradually. Fane and Phillips (1991) and Fane and Condon (1996) indicated that the trade reforms decreased the nominal rate of protection (defined as the import tariff plus the import charge) in non-oil manufacturing industries (industries varies from food to machinery) from 21% in 1987 to 11% in 1990 and further to 6% in 1995. They further noted that the effective rate of protection (nominal rate of protection corrected for wage) fell from 80 % in 1987 to 35% in 1990 and to 25% in 1995. In 1993, the World Bank (World Bank, 1993) reported that Indonesia is among the newly industrialized economies along with other South Asian and Southeast Asian countries such as South Korea, Taiwan, Singapore, Malaysia and Thailand. In 1980, the value added contribution of manufacturing industries to total GDP was 13.4% which increased to 19.6% in 1990 and reached 26.7% in 2001. Meanwhile, the total export in 1980 was US $ 21,909 millions of which 2.3% (US $ 500.6 Millions) was from manufacturing industries (World Bank, 2003). The export from manufacturing industries continued to increase and by 1990 it was worth US $ 9,102.6 millions and accounted for 35.5% of the total export in that year. In 2001 more than 56% of the total export was from manufacturing industries (Central Bureau of Statistics, 2003). However, within the period of financial crisis, manufacturing industries experienced a sharp decline in output. Thee (2000) noted that in 1998 manufacturing output decreased by 12.9%, and between 1996 and 1998 medium and large establishment's share was down by 11%.

The structure of Indonesian manufacturing industries is dominated by food, beverage and tobacco products sectors (ISIC 31), textile, wearing apparel and leather products sectors (ISIC 32), and chemical, plastic and petroleum products (ISIC 35). The value added of these three sectors accounted for more than 50% of the total value added of manufacturing sector in 2001. Among those three sectors, ISIC 31 (later called food sector) has dominated manufacturing industry sector since 1998. The contribution of this sector to the total manufacturing value added from 1998 to 2001 has been the largest among all sectors namely more than 20%. The second largest contributor was ISIC 32 (later called textile sector). The share of this sector to the total manufacturing value added was 17.42% in 1998 and has slightly decreased to 15.52% in 2001. Meanwhile, ISIC 35 (later called chemical sector) was recorded as the third largest contributor to the total manufacturing value added. The value added of this sector accounted for 14.62 % and 13.2% of total manufacturing value added in 2000 and 2001 respectively.

3. Methodology

Consider a production function of panel data:

$$y_{it} = f(x_{jit}; a)\exp(e_{it}) \qquad (1)$$

where $i = 1, 2, 3, \ldots, I$ represent cross sectional units, $t = 1, 2, 3, \ldots, T$ represent time periods, y_{it} is the output of ith unit at time t, x_{jit} is the jth input of ith unit at time t, $j = 1,2,3,\ldots, J$ and a is a vector of unknown parameters. The error term e_{it} is divided into two components: the random error v_{it} and the inefficiency part u_{it}, i.e., $e_{it} = v_{it} - u_{it}$. The v_{it}'s are assumed to be independent and identically distributed as normal with mean 0 and variance s_v^2 and we assume that u_{it}'s follow a truncated normal distribution with m as the mode, i.e., $u_{it} \sim N^{+}(m, s_u^2)$. An excellent review of theory and application of stochastic frontier models is given by Coelli, Rao and Battese (1998) and Kumbhakar and Lovell (2000). Battese and Coelli (1988) extended the work of Jondrow et al. (1982) to the case of panel data assuming that technical efficiency is time invariant. In practice it seems natural to relax the assumption that technical efficiency is time invariant. For that reason, we follow Battese and Coelli (1992) who propose a stochastic frontier production model for panel data permitting technical efficiency vary over time[1]. They define u_{it} to accommodate time-varying assumption as follows:

$$u_{it} = h_t u_i \qquad (2)$$

---

[1] Some studies use different specifications of time varying model. Cornwell, Schmidt and Sickles (1990) propose $h_{it} = g_1 + g_2 t + g_3 t^2$ and Kumbhakar(1990) defines $h_{it} = [1 + \exp(g_1 t + g_2 t^2)]$.

where $h_t = \exp\{-d(t-T)\}$. d is a parameter that plays important role in the behavior of technical efficiency over time. Battese and Coelli (1992) note that if $d > 0$, technical efficiency rises at a decreasing rate, if $d < 0$ technical efficiency declines at an increasing rate, and if $d = 0$ the technical efficiency remains the same. Following Battese and Coelli (1992), we estimate technical efficiency by the minimum mean-square-error predictor, i.e.,

$$
\begin{aligned}
TE_{it} &= E[\exp(-u_{it}) \,|\, e_i] \\
&= \left[\frac{1-\Phi(h_t s_* - (m_{*i}/s_*))}{1-\Phi(-(m_{*i}/s_*))} \right] \exp\{-h_t m_{*i} + 0.5 h_t^2 s_*^2\}
\end{aligned}
\tag{3}
$$

where

$$
m_{*i} = \frac{m s_v^2 - h' e_i s_u^2}{s_v^2 + h'h s_u^2}, \tag{4}
$$

$$
s_*^2 = \frac{s_u^2 s_v^2}{s_v^2 + h'h s_u^2}, \tag{5}
$$

$h' = (h_1\ h_2\ h_3\ h_4 \cdots h_T)$ and $\Phi(\bullet)$ is the standard normal cumulative distribution.

In this study, we use translog production function to represent the production technology:

$$
\begin{aligned}
\ln y_{it} = {} & b_0 + b_k \ln k_{it} + b_l \ln l_{it} + b_m \ln m_{it} + b_t t \\
& + \frac{1}{2}\left[b_{kk}(\ln k_{it})^2 + b_{ll}(\ln l_{it})^2 + b_{mm}(\ln m_{it})^2 + b_{tt} t^2 \right] \\
& + b_{kl} \ln k_{it} \ln l_{it} + b_{km} \ln k_{it} \ln m_{it} + b_{lm} \ln l_{it} \ln m_{it} \\
& + b_{kt} t \ln k_{it} + b_{lt} t \ln l_{it} + b_{mt} t \ln m_{it} + v_{it} - u_{it}.
\end{aligned}
\tag{6}
$$

where y is gross total output, k is capital, l is labor, m is material and subscript i and t (i = 1, 2, 3, …, I and t = 1,2,3, …, T) indicate the ith firm at tth year for each sectoral industry.

Next, the factors affecting technical inefficiency are examined by using the following model:

$$TIE_{it} = d_0 + d_1 z_{1it} + d_2 z_{2it} + d_3 z_{3it} + ... + d_n z_{nit} + x_{it} \tag{7}$$

where TIE_{it} is technical inefficiency of firm i at period t, $z_{1it}, z_{2it}, z_{3it},..., z_{nit}$ are the n independent variables, $d_1, d_2, d_3,..., d_n$ are the parameter to be estimated and x_{it} is an error term. In this study, we consider regional location, age, ownership and firm size as factors which are considered to have effect on inefficiency.

Kumbhakar and Lovell (2000, p.279) note that total factor productivity (TFP) growth, denoted by $\dot{TFP}$, can be decomposed into three components: rate of technological change (TP), a scale component (SC) and a change in technical efficiency $\dot{TE}$. Furthermore, they define a rate of technological change as the partial derivative of the production function with respect to time, scale component is the scale elasticity contribution to the TFP growth and technical efficiency change is the derivative of technical efficiency with respect to time. Hence, for the translog production function specified in equation (6) and time varying technical efficiency denoted in equation (2) technological progress and scale component can be expressed as

$$\begin{aligned} TP &= \frac{\partial \ln(y_{it})}{\partial t} \\ &= b_t + b_{tt} t + b_{kt} \ln k_{it} + b_{lt} \ln l_{it} + b_{mt} \ln m_{it}, \end{aligned} \tag{8}$$

$$SC = (e-1)\sum_j \left(\frac{e_j}{e}\right)\dot{x}_j, \quad (9)$$

where $e_j,\ j = 1,2,3,...,J$ are elasticities of output with respect to input *j*, $e = \sum_j e_j$ and

$\dot{x}_j$ denotes the rate of change of input x_j. Further, the technical efficiency change is estimated by

$$\begin{aligned} \dot{TE} &= -\frac{\partial u_{it}}{\partial t} \\ &= d\ \exp\{-d\,(t-T)\}u_i \end{aligned} \quad (10)$$

Thus, using decomposition method introduced by Kumbhakar and Lovell (2000, p.284), TFP growth can be calculated as

$$\begin{aligned} \dot{TFP} &= TP + SC + \dot{TE}. \\ &= (b_t + b_{tt}t + b_{kt}\ln k_{it} + b_{lt}\ln l_{it} + b_{mt}\ln m_{it}) + \\ &\quad (e-1)\sum_j \left(\frac{e_j}{e}\right)\dot{x}_j + dh_t u_i. \end{aligned} \quad (11)$$

4. Data

The yearly data from 1993 to 2000 is obtained from yearly surveys of medium and large size manufacturing firms conducted by the Central Bureau of Statistic (CBS) Indonesia. For each year, we have 733 firms consisting of four sectors: Food (ISIC 31), Textile (ISIC 32), Chemical (ISIC 35) and Metal Products (ISIC 38). The total firms are classified as food: 259; textile: 230; chemical: 128 and metal products: 116. Gross total output, *y*, is the total value of a firm's output in a specific year; capital, *k*, is the total cost of firms' capital depreciation and interest paid by the firm; and labor, *l*, is the total number of employees. Number of employees is used instead of manhours due to the unavailability of the data. Material, *m*, is the total value of the material used by firms. All variables, except labor, are in 1993 thousand rupiah price. The regional location of a firm, the ownership and the firm size are represented by binary variables. Regional location, (later called the region) variable takes value 1 if a firm is located in the western part of Indonesia, and 0 otherwise. Ownership variable takes a value 1 if a firm is a private establishment and 0 if it is a public establishment. The dummy variable for size, DS_i, is defined as follows: DS_i = -1 if the output of the *i*th firm is less than 50 billions rupiah (small size firms), DS_i = 0 if the output is between 50 billions and 100 billions rupiah (medium size firms) and DS_i = 1 if the output is more than 100 billions rupiah (large size firms). Following Lundvall and Battese (2000) the maturity of firm is represented by the natural logarithm of firm's age.

5. Technical Efficiency and its determinants

5.1. Technical efficiency

Model given by equation (6) is estimated by the maximum likelihood method using FRONTIER 4.1 software (Coelli, 1996)[2] where u_{it} follows truncated normal distribution with mode m and variance s_u^2, and the time varying set up of u_{it} is specified by equation (2). Note that for food, textile, chemical and metal products sectors the total number of firms are 259, 230, 116 and 128 respectively. Parameter estimates of the model are reported in Table 1. We observe that b_k is positive and statistically significant in the chemical and metal products sectors indicating that the capital plays crucial role in

[2] The authors would like to thank to Tim Coelli for providing Frontier 4.1

these two sectors whereas b_l is significant in textile sector and b_m is significant in the chemical sector.

Table 1 is here

The technical efficiency for each firm is estimated by the minimum mean square error predictor, i.e., by using equation (3). The yearly average, the overall averages of all sectors and the growth rates of technical efficiencies for four sectors are presented in Table 2[3]. The results reveal that average technical efficiencies in Indonesian manufacturing industries vary from the lowest of 42.40% (food in 1993) to 85.78% (metal products in 2000). During the period of investigation textile is the least efficient sector, i.e., 47.89% while metal product is the most efficient sector, i.e., 68.91%. It is worth noting that average technical efficiency increased over time for all sectors. During

Table 2 is here

this period the efficiency of food sector increased from 42.40% in 1993 to 58.96% in 2000. Textile firms have lowest efficiency growth over the period which is 1.13% per annum whereas the highest growth rate is in metal sector which grew 8.93% per annum. However, during the same period the efficiency of food and chemical sectors grew at the rate of 4.83% and 2.49% respectively. From Table 2, we note that the growth rate of efficiencies for all four sectors is higher during 1994-1997 than 1998-2000 i.e., on average efficiencies decreased after the Asian crisis hit Indonesia. One explanation could

[3] The detailed results for each firm are available from the authors.

be that during the recession the firms generally operate more inside its production possibilities frontier.

Furthermore, the detailed analysis of the efficiency in the form of frequency distribution is presented in Table 3. We note that in general, from 1993 to 2000, technical efficiencies increased in all sectors. However, the food sector gained the maximum efficiency over this period. In 1993, more than half of the firms were at most 40% technically efficient, but in 2000 almost all firms were more than 40% technically efficient. Note that in 1993, only 43% of the firms in the food sector were 40% and more efficient, but in 2000 this number increased to 94%. From Table 3, we also note that in 1993, 58% of firms in the textile sector were 40% and more efficient. However, in 2000 this number increased to 71%. In the chemical sector, in general, the technical efficiency

Table 3 is here

of firms increased from 1993 to 2000. In 1993, 53% of the firms were 60% and more efficient, but in 2000 the number of firms in the same range of efficiency increased to 91%. Further, we note even greater improvements in efficiency in metal products sector. In 1993, more than 75% of the firms had technical efficiencies below 60% and only less than 24% firms had efficiencies above 60%. However, in 2000 all firms were 60% or more efficient and among these, almost 84% were 80% technically efficient.

5.2 Determinants of Technical Inefficiencies

Next, we analyze the efficiencies based on firm sizes, ownerships and regions. For the purpose of firm-size analysis, firms are grouped into three categories, i.e., small, medium and large. A firm is considered small if its output is less than 50 billion rupiahs, a medium if its output is between 50 billion and 100 billion rupiahs, and large if its output is more than 100 billion rupiahs[4]. Table 4 exhibits average efficiencies for each of the four sectors according to the sizes of the firms. We note that in the food sector, larger firms are consistently less efficient throughout the period of study, However, in the case

Table 4 is here

of the other three sectors, i.e., textile, chemical and metal products sectors, larger firms are more efficient. In the textile sector the difference in efficiency of smaller and larger firms stayed almost at the same level from 1993 to 2000. But in the chemical and metal products sectors the gap in efficiencies narrowed in 2000 compared to 1993. As noted earlier, in the food sector large firms are less efficient than small and medium firms. This is consistent with the observation made by Central Bureau of Statistics in Indonesia (based on the inputs and output ratios) that medium firms in the food sector tend to be more efficient than the larger firms (Badan Pusat Statistik, 2000, p. 11). In the food sector we also note that the smaller firms are more efficient than the larger firms. This is due to the fact that food sector in Indonesia is more domestic oriented, especially for small and medium firms and thus they tend to be more efficient. Small domestic oriented firms tend to have lower operating costs and better service to customers and thus, tend to be more efficient. In contrast, the other three sectors are more technologically advanced and more capital oriented compared to the food sector. Generally, firms which are capital oriented have a tendency to be more efficient and since chemical and metal products are capital

[4] Any size classification is arbitrarily. We chose to classify firms based on output.

oriented, not only they are more efficient sectors as compared to food sector but their technical efficiencies also increased faster than those of the food sector during 1993 to 2000.

Average technical efficiencies for four sectors by type of ownership and region are shown in table 5. For all sectors the firms in eastern region are more efficient than those in the western region, although the differences are not noticeable. This is very surprising, given the fact that the western region of Indonesia is more developed than the eastern region. Thus, we can conclude that in the case of Indonesian manufacturing industry, having more developed environment does not necessarily make firms more efficient. Generally, it is expected that public firms on average tend to be less efficient as compared to private firms. However, here we note that the difference between technical efficiencies of public-owned and private-owned firms is negligible. Thus in the case of Indonesia, public and private firms are equally efficient.

Table 5 is here

Average technical efficiencies by firm age are shown in Table 6. It indicates that there is no clear pattern whether technical efficiency is related to firm age. In food and chemical sectors, firms which are 15 years old or less were less efficient than the firms between 15 and 45 years old. However, firms which are more than 45 years old are less efficient than the younger firms. In the chemical sector, we note that the older firms tend to be consistently less efficient. On the other hand, average technical efficiencies in the

Table 6 is here

metal products sector show firms had peak efficiency performance when they were between 15 and 30 years old. In sum, with the exception of the chemical sector, we note that there is no association between firm's age and the technical efficiencies which is consistent with the case of African manufacturing industry (Mengistae, 1996) and Kenyan manufacturing industry (Lundvall and Bettese, 2000).

6. Correlates of Technical inefficiencies

To examine the correlates of technical inefficiencies equation (6) is estimated. Technical inefficiency is defined as $TIE_{it} = 1 - TE_{it}$, where TE_{it} is technical efficiency. Along with the size of firms, other variables which are region, ownership and age are utilized to investigate the correlates of technical inefficiencies. As shown in Table 4, except for food sector, large firms are more efficient than small and medium firms. Thus, the firm size coefficients are expected to affect negatively to inefficiencies. There is no a-priori judgment on the signs of the regional coefficients. Nevertheless, based on the result in Table 5, the regional coefficient may not be significant. Ownership dummy variable is intended to capture the effect of private-public firm dichotomy. Since the ownership dummy variable is defined as 1 if a firm is a private establishment, we expect the estimated coefficient to be negative. In other words, inefficiencies decrease as firms move from public to private ownership. Note that the general perception is that the private firms are more efficient than public firms. Many studies indicated that correlation between age and technical efficiency is ambiguous. (e.g. Little et al., 1987 and

Mengistae, 1996) which is also noted here in Table 6 for Indonesian manufacturing industries.

The parameter estimates along with their standard errors from regression equation (6) are summarized in Table 7. The results reveal that the signs and significance of coefficients vary across sectors. The sign of all size coefficients are negative and significant which mean that as a firm becomes larger its inefficiency decreases, hence large firms were more efficient than small firms. Except for food sector, this conclusion is also confirmed by the results in Table 4. The regional coefficient is significant in the textile sector and insignificant in the other three sectors. This confirms the conclusion drawn from Table 5, i.e., the regional variable does not play any important role in

Table 7 is here

determining the efficiency. The coefficients of the ownership are significant and have negative signs, except in the textile sector. This also reaffirms the findings of Table 5, i.e., ownerships affects positively to efficiencies. However, the effect of the age of a firm variable in all sectors is not consistent. This is also noted in Table 6. In food and textile sectors this variable is not statistically significant. However, in the chemical and the metal products sector, this is significant but has different signs.

7. Total Factor Productivity and Elasticity Analysis

7.1. Total Factor Productivity (TFP)

The summary of the estimates of the sectoral total factor productivity growth ($\dot{TFP}$), technological progress (*TP*), scale component (*SC*) and technical efficiency changes ($\dot{TE}$) are reported in Table 8[5]. Food sector shows consistently negative

Table 8 is here

productivity growth. However, there is an upward trend of TFP growth from 1994 to 2000. In 1994, TFP decreased by 4.59 %, three years later it only declined by 2.29%, but in 2000 TFP increased by 0.07%. From the three components of $\dot{TFP}$, we note that the negative growth of TFP in this sector was due to technological recess. However, like the TFP growth the technological progress also improved from 1994 to 2000, i.e., it decreased by 11.11% in 1994 but it only decreased by 6.81% and 2.84% in 1997 and 2000 respectively. Unlike in the food sector, total factor productivity in the textile sector recorded positive growth during the first 4 years, i.e., from 1994 to 1997, and negative growth after these periods. However, total factor productivity growth declined from 1994 to 1999. Total productivity increased by 3.20% in 1994 but in 1997 it only increased by less than 1% and in 1998 productivity decreased by 6.23%. Interestingly, from 1994 to 1998, the performance of productivity was dictated by technological progress, but in 1999 and 2000 scale component played the larger role. For the textile sector, the contribution of technical efficiency changes to total factor productivity growth was stable, which is slightly above 1%.

[5] The detailed results are available from the authors.

It is interesting to note that chemical sector is the only sector where average total factor productivity over period of study is positive, i.e., 0.5%. Like in textile sector, with exception of 1997, TFP growth declined from 1994 to 2000. Total factor productivity grew 2.27%, 1.58% and 1.06% in 1994, 1995 and 1996 respectively and the lowest productivity growth was recorded in 2000 which was –1.06%. It is worth mentioning that in the chemical sector the contribution of scale component to total factor productivity growth was negligible and $\dot{TE}$ stayed almost constant. But the $\dot{TFP}$ decreased due to a technological recess, i.e., the chemical industries did not keep up with the technological progress.

The characteristics of the total factor productivity growth in metal products sector is similar to that of food sector, i.e., for almost all the years the total factor productivity growths were negative. However, unlike in the food sector, productivity declined from 1994 to 1996, i.e., from 0.74% to –2.36%, improved slightly for the next two years (–2.09%. and –1.40%) but declined sharply in 1999 (–4.71%) before slight recovery in 2000 (–1.03%). The three components of the total factor productivity growth in this sector indicate that technological progress improved over time but was still the main factor of a decline in $\dot{TFP}$. In 1994, the technological recess was –13.08%, but in 2000, it was only 3.04%. Meanwhile, technical efficiency changes in this sector were the largest among all four sectors. However, from 1994 to 2000, the technical efficiency changes decreased which could be due to technological recess. Comparison of the TFP among the four sectors yield the conclusion that over the period of the study, TFP growth in the food and metal products sectors recorded negative growth with an exception in 2000 for food sector and in 1994 for the metal products sector. Such decline in TFP can be attributable to different factors. One of them, perhaps, is due to the fact that those two sectors, especially food sector, are not export oriented sectors. Study of Hallward-Driemeier, Iarossi and Sokoloff (2002) pointed out that export oriented firms tend to have higher productivity growth as compared to domestic oriented firms. For the same reason, the textile sector recorded positive TFP growth, since this is an export oriented sector.

Compared to the results of other TFP growth studies on Indonesian manufacturing the estimates of the TFP growth in this study are somewhat lower in some sectors and higher in the other sectors. Timmer (1999) reported that the TFP growth estimates for the food and the textile sectors for the period 1991-1995 were 5.7% and 3.6%, while for chemical and metal products sectors were -0.3% and 6.9%. Aswicahyono and Hill (2002), based on 28 firms, concluded that the TFP growth of Indonesian manufacturing over the period 1981-1993 was -4.9%. Unfortunately, their study does not provide estimates on sectoral basis. The contrasting results among the studies may be due to the different time periods, data sets used, variables employed in the model and methodological approach.

Next, to analyze further, the average total factor productivity growths are broken down into two periods, i.e., before the Asian crisis hit Indonesia (1994 – 1997) and after the Asian crisis hit Indonesia (1998-2000). In the food sector, before the Asian crisis hit Indonesia (1994 – 1997), $\dot{TFP}$ declined 3.53% per annum which was higher than that of entire period in this sector (which was 2.73%). However, $\dot{TFP}$ slightly recovered for the next period (1998 – 2000) i.e., only decreased by 1.66% per annum. On the other hand, $\dot{TFP}$ in the textile, chemical and metal products sectors before the Asian crisis were better than after the Asian crisis hit Indonesia. In this period, total factor productivities in textile and chemical sectors were able to grow 1.81% and 1.21% per annum respectively, while in metal products sector, total factor productivity decreased by 1.10% per annum. However, in these three sectors, after the Asian crisis hit Indonesia, $\dot{TFP}$ decreased to –3.02%, –0.46% and –2.38% for textile, chemical and metal products sectors respectively. Thus, our results reveal that the Asian crisis affected the total factor productivity growths more in the textile, chemical and metal product sectors as compared to the food sector. This could be due to the fact that the food sector is primary domestic, neither uses imported inputs nor does it exports. On the other hand, textile, chemical and metal products are more advanced sectors in economy, i.e., in using technology and imported materials.

Table 8 further reveals that the technological progress was mostly negative in all sectors except for the textile sector in the period of study. The magnitudes of the technological recess indicate that declines in total factor productivities were contributed by technological recess, since all technical efficiency changes are small and positive. It is interesting that in the metal products sector for all periods, the magnitudes of the technological progress and technical efficiency changes are relatively the same. It suggests that although technical efficiency changes were high, but were not enough to make the total factor productivity to grow. It is worth noting that total factor productivity growths for textile, chemical and metal products sectors in 1999 were the worst among all years. We believe that this is due to the effect of the Asian crisis that occurred in the middle of 1997. It seems that the total factor productivities were affected by the Asian crisis severely in 1999 and recovered in 2000. In the food sector, the effect of the Asian crisis was also recorded. However, the effect is not as severe as the one to the other three sectors.

To obtain an indepth analysis of the TFP growth in all sectors we analyze its frequency distribution. The frequency distribution of the $\dot{TFP}$ is reported in Table 9. In the food sector, almost all firms had $\dot{TFP}$ less than 5% throughout the period of the study. Moreover, it is interesting to note that 40.54% of firms in this sector had TFP growth between -10.00% and –5.00% in 1994 and it decreased to 5.79% in 2000, while firms having TFP growth between zero and 5.00% increased from 7.34% in 1994 to 39.38% in 2000. In summary, only 7% of the firms in the food sector had positive growth

Table 9 is here

in 1994 and it increased to almost 49% in 2000. However, the textile sector shows the opposite trend, i.e., 21% of the textile firms recorded negative TFP growth and 79% recorded positive TFP growth in 1994. But in 2000 the negative TFP growth is noted in 72% of the firms and only 26% had positive TFP growth. Analyzing in detail we note that the number of firms having TFP growth between –10.00% to –5.00% increased from 5.22% in 1994 to 16.09% in 2000, whereas firms that had TFP growth between zero and 5.00% decreased from 43.48% in 1994 to 26.09 in 2000. It is also worth mentioning that in 1994, almost 30% firms had TFP growth between 5.00% and 10.00%, but in 2000, their TFP growths declined and no firm had TFP growth above 5%. For the chemical sector, almost 80.00% of the firms had positive in 1994 but firms with positive growth declined to only 34% in 2000. Note that, the firms having TFP growth between 5.00%

and 10.00% decreased 19% in 1994 to zero in 2000. For the metal products sector, the frequency distribution of the TFP growth reveals that the firms with negative and positive TFP growths were equally divided (i.e., 50% each). However, in 2000 the number of firms with negative TFP growths increased to 63%. Analyzing further we note that the firms having TFP growths between –5.00% and 0.00% increased from 17% in 1994 to 55% in 2000. On the other hand, firms having TFP growth between 5.00% and 15.00% decreased from 22% in 1994 to only 3% in 2000. The frequency distribution of total factor productivity growths also suggest that before Asian crisis hit Indonesia, the growths were stable except in the food sector, but after the Asian crisis struck the total factor productivity deteriorated, especially in 1999.

Total factor productivity growths for four sectors by firm size are presented in Table 10. The results reveal that during 1993 – 2000 TFP growth decreased more for larger firms as compared to medium and small firms for food, textile, and metal product sectors. However, for the chemical sector, the only sector that recorded positive average $\dot{TFP}$, the average total factor productivity growth for large firms is almost the same as that of small firms. But for the food sector, the total factor productivity growth for large firms in food sector was the greatest, i.e., –5.01% as compared to –2.30% for small and

Table 10 is here

–4.67% for medium firms. Textile and metal products sectors also exhibit the same trend, i.e., the average of TFP growth for large firms was the greatest compared to the small and medium firms within the sector. We also note that the total factor productivity growths for food, textile and metal products were driven mainly by the large firms. But for the chemical sector, it was driven by the medium firms.

Comparisons of total factor productivity growths between the firms located in eastern and western firms, and between publicly-owned and privately owned firm are reported in Table 11. The results are consistent with technical efficiency analysis described earlier, i.e., on average there is no difference in TFP growth between the

Table 11 is here

eastern and western regions of the county. However, for the metal products sector the total factor productivity between two regions were quite different. For the eastern region the average $\dot{TFP}$ was –2.43% and for western region it was –1.58%. The TFP growth is almost invariant to the ownership characteristic of firms, i.e., whether the firms are privatey owned or publicly owned the average TFP growths over the entire periods are almost the same with few exceptions. For example, in 1998, the $\dot{TFP}$ of public-owned firms in the textile sector was –2.61% while for private-owned firms it was 0.42%. Also in 1997, the $\dot{TFP}$ for public and private owned chemical firms were 0.31% and –0.26% respectively. And finally, for the metal products sector in 1995, $\dot{TFP}$ for public firms was 0.52% while $\dot{TFP}$ for private firms was –1.35%.

6.2 Elasticities

It is useful to examine how much output will increase when the level of input increases. This notion can be examined by estimating the elasticities of output with respect to capital, labor and material. The elasticity of output with respect to capital, e_k, is estimated by:

$$e_k = b_k + b_{kk} \ln k_{it} + b_{kl} \ln l_{it} + b_{km} \ln m_{it} + b_{kt} t, \tag{12}$$

whereas the elasticity of output with respect to labor, e_l, is estimated by

$$e_l = b_l + b_{ll} \ln l_{it} + b_{kl} \ln k_{it} + b_{lm} \ln m_{it} + b_{lt} t, \tag{13}$$

and the elasticity of output with respect to material, e_m ,is estimated by

$$e_m = b_m + b_{mm} \ln m_{it} + b_{km} \ln k_{it} + b_{lm} \ln l_{it} + b_{mt} t. \tag{14}$$

The elasticities of output with respect to each input are estimated at their mean values are reported in Table 12. The total elasticities (e) for the food sector in small, medium and large firms suggest that this sector exhibit constant return to scale irrespective of the size of the firm. Furthermore, by comparing elasticities of output with respect to capital, labor and material, we note that that outputs of medium and large firms in food sector are driven more by material rather than by capital or labor. However, in the case of small firms, elasticity of output with respect to capital is larger than elasticity of material and labor.

Table 12 is here

Moreover, the total elasticities in textile sector reveal that small and medium firms exhibit decreasing return to scale but the large firms exhibit constant returns to scale. On the other hand all the firms irrespective to their size, in the chemical and metal products sector exhibit constant returns to scale. In all three sectors (textile, chemical and metal products) elasticities of output with respect to capital are higher than elasticities of output with respect to labor and material. Thus, these three sectors are capital oriented and are highly technology oriented compared to the food sector. It is worth noting that for the food and chemical sectors, as firms became larger the elasticities of output with respect to capital decreased, whereas in textile and metal products sectors, as firms became larger the elasticities of output with respect to capital increased. It indicates that in food and chemical sectors, as size of a firm increased, a percentage increase in capital has a smaller percentage effect on output. However, in textile and metal products sectors, as size of a firm increased, a percentage increases in capital has a larger percentage effect on output.

8. Summary and Conclusions

In this paper, the technical efficiencies of food, textile, chemical and metal products sectors in Indonesia during 1993-2000 are estimated by using a translog production function. The results indicate that average technical efficiency of all the four sectors was 55.87%. It indicates that firms in these four sectors, on average, were operating only 55.87% of their potential outputs. In the food sector, the average technical efficiency was 50.79%. This result is almost identical to the average efficiency of Singaporean food industry between 1976 and 1994 which was 52.2% (Mahadevan, 2000). The average technical efficiency in the textile sector was the lowest among four sectors, i.e., 47.89%. However, this result is lower than the 66% efficiency obtained for the Indonesian garment industry by Battese et al. (2001) over the period 1990 to 1995. The average efficiencies for the chemical and metal products sectors are almost the same, i.e., 68.65% and 68.91%, respectively. Annual growth rates of technical efficiencies suggest that all four sectors were affected by the Asian crisis. In all sectors, the growth rates over the period of the Asian crisis (1998-2000) are smaller than the growth rates before the Asian crisis (1994-1997) hit Indonesia. The average growth rate for these four sectors over the period 1998-2000 was 3.22% per annum, but before that period it was 4.62% per annum. As far as the factors contributing to inefficiencies is concerned, it is noted that except for the food sector, the larger firms are more efficient, but the inefficiencies are invariant to regional location (west versus east) of the firm. The ownership of a firm (public versus private) had an effect on efficiency except for the textile sector but the age of a firm had almost no effect on the efficiencies of Indonesian firms. This result is in line with the finding of Lundvall and Battese (2000) for Kenyan manufacturing efficiencies.

The estimates of the TFP growth reveal that during the period under investigation the average TFP growth was -2.73% for the food sector,-0.26% for the textile sector, and -1.65% for the metal products sector. The chemical sector is the only sector which recorded positive growth, i.e., 0.5%. These results are somewhat lower as compared to Singapore manufacturing industry. For Singapore, Koh et al, (2002) reported that for the period 1996-1998, the TFP growth for the food sector was -1.9%, for the metal products sector TFP growth was -1.9%, and for the chemical sector it was 0.7%. We also note that the average TFP growth for the food sector improved from -3.53% before Asian crisis (1994-1997) to -1.66% after Asian crisis (1998-2000). However, for the other three sectors, i.e., textile, chemical and metal products, the TFP growths declined, i.e., from 1.81% to -3.02%, from 1.21% to -0.046% and from -1.1% to -2.38%, respectively after the Asian crisis. Thus, the hypotheses that the Asian crisis effected the TFP growth in manufacturing in Indonesia are confirmed in the textile, chemical and metal products sectors.

The elasticities of output with respect to capital are higher than the elasticities of output with respect to material and labor for textile, chemical and metal products. However, for the food sector the elasticity of output with respect to material is higher than the elasticity of output with respect to capital. This indicates that the output growths in textile, chemical and metal products sector are driven by capital rather than by material or labor. This points to the conclusion that these three sectors are more capital oriented as compared to the food sector.

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Table 1. Parameter Estimates of Production Functions
(1993 – 2000)

Variable	Parameter	Sector							
		Food		Textile		Chemical		Metal Products	
		Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Intercept	a_0	8.6794**	0.9948	6.7393**	0.9751	5.3336**	1.0056	9.9350**	0.9804
ln k	a_k	0.8136	0.7490	-0.1489	0.1571	1.5809**	0.1575	0.4060**	0.1493
ln l	a_l	0.1307	0.3005	1.3939**	0.1880	0.0001	0.1618	0.2416	0.1907
ln m	a_m	-0.5631	0.6706	0.1323	0.1243	-0.5725**	0.1238	-0.1662	0.1182
t	a_t	0.1054**	0.0455	0.0194	0.0373	-0.1325	0.0681	-0.1819**	0.0617
$0.5(\ln k)^2$	a_{kk}	0.0115	0.0566	0.2235**	0.0225	-0.0008	0.0214	0.2390**	0.0200
$0.5(\ln l)^2$	a_{ll}	0.0346*	0.0172	0.2010**	0.0341	-0.0720**	0.0264	0.1418**	0.0266
$0.5(\ln m)^2$	a_{mm}	0.1250**	0.0459	0.0126	0.0135	0.0743**	0.0076	0.0889**	0.0101
$0.5t^2$	a_{tt}	0.0156**	0.0045	-0.0072*	0.0033	-0.0044	0.0044	0.0150**	0.0064
$(\ln k)(\ln l)$	a_{kl}	0.0416	0.0259	-0.2354**	0.0248	0.0012	0.0147	-0.1657**	0.0174
$(\ln k)(\ln m)$	a_{km}	-0.0435**	0.0097	-0.0314*	0.0137	-0.0543**	0.0133	-0.1229**	0.0110
$(\ln l)(\ln m)$	a_{lm}	-0.0497**	0.0136	0.0301	0.0174	0.0381**	0.0096	0.0836**	0.0116
$t(\ln k)$	a_{kt}	-0.0105	0.0063	-0.0109**	0.0039	0.0150**	0.0061	-0.0061	0.0056
$t(\ln l)$	a_{lt}	0.0002	0.0042	0.0144**	0.0061	-0.0073	0.0050	0.0102	0.0075
$t(\ln m)$	a_{mt}	-0.0075	0.0056	0.0045	0.0024	-0.0023	0.0031	0.0026	0.0047
	s_u^2	0.1186**	0.0100	0.1083**	0.0061	0.0458**	0.0025	0.0733**	0.0049
	g	0.3423**	0.0160	0.7414**	0.0111	0.2457**	0.0116	0.0531**	0.0022
	m	0.4030**	0.0766	0.5667**	0.0332	0.2122**	0.0100	0.1248**	0.0082
	d	0.0762**	0.0096	0.0165**	0.0055	0.0697**	0.0112	0.2420**	0.0100

Note: * and ** indicate significance at 5 % and 1 % level of significance respectively.

Table 2. Average Technical Efficiencies

Year	Sector				Average
	Food	Textile	Chemical	Metal Products	
1993	0.42396	0.46000	0.62554	0.47348	0.47831
1994	0.44838	0.46542	0.64411	0.54654	0.50344
1995	0.47270	0.47084	0.66213	0.61559	0.52781
1996	0.49685	0.47624	0.67956	0.67859	0.55105
1997	0.52070	0.48162	0.69639	0.73441	0.57294
1998	0.54417	0.48699	0.71261	0.78270	0.59339
1999	0.56716	0.49235	0.72820	0.82365	0.61240
2000	0.58959	0.49769	0.74315	0.85783	0.63002
Average	0.50794	0.47889	0.68646	0.68910	0.55867
	Annual growth Rates of Technical Efficiencies (%)				
1994-2000	4.83	1.13	2.49	8.93	4.02
1994-1997	5.27	1.15	2.72	11.63	4.62
1998-2000	4.23	1.10	2.19	5.32	3.22

Table 3. Frequency Distribution of Technical Efficiencies

Class	1993		1994		1995		1996		1997		1998		1999		2000	
	Freq.	r.f	Freq.	r.f	Freq.	r.f	Freq.	r.f	Freq.	r.f	Freq.	r.f	Freq.	r.f	Freq.	r.f
Food																
$0.0 < TE \leq 0.2$	13	5.02	5	1.93	2	0.77	2	0.77	2	0.77	2	0.77	2	0.77	2	0.77
$0.2 < TE \leq 0.4$	134	51.74	130	50.19	108	41.70	79	30.50	62	23.94	36	13.90	24	9.27	13	5.02
$0.4 < TE \leq 0.6$	72	27.80	81	31.27	101	39.00	127	49.03	135	52.12	151	58.30	146	56.37	143	55.21
$0.6 < TE \leq 0.8$	20	7.72	21	8.11	25	9.65	28	10.81	35	13.51	42	16.22	58	22.39	71	27.41
$0.8 < TE \leq 1.0$	20	7.72	22	8.49	23	8.88	23	8.88	25	9.65	28	10.81	29	11.20	30	11.58
Total	259	100.00	259	100.00	259	100.00	259	100.00	259	100.00	259	100.00	259	100.00	259	100.00
Textile																
$0.0 < TE \leq 0.2$	1	0.43	1	0.43	1	0.43	1	0.43	1	0.43	1	0.43	1	0.43	1	0.43
$0.2 < TE \leq 0.4$	96	41.74	93	40.43	90	39.13	84	36.52	80	34.78	73	31.74	68	29.57	66	28.70
$0.4 < TE \leq 0.6$	91	39.57	94	40.87	96	41.74	101	43.91	104	45.22	111	48.26	115	50.00	116	50.43
$0.6 < TE \leq 0.8$	31	13.48	30	13.04	30	13.04	31	13.48	32	13.91	32	13.91	32	13.91	32	13.91
$0.8 < TE \leq 1.0$	11	4.78	12	5.22	13	5.65	13	5.65	13	5.65	13	5.65	14	6.09	15	6.52
Total	230	100.00	230	100.00	230	100.00	230	100.00	230	100.00	230	100.00	230	100.00	230	100.00
Chemical																
$0.0 < TE \leq 0.2$	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
$0.2 < TE \leq 0.4$	7	5.47	2	1.56	2	1.56	2	1.56	1	0.78	1	0.78	0	0.00	0	0.00
$0.4 < TE \leq 0.6$	53	41.41	53	41.41	48	37.50	42	32.81	39	30.47	30	23.44	20	15.63	12	9.38
$0.6 < TE \leq 0.8$	46	35.94	50	39.06	52	40.63	56	43.75	58	45.31	66	51.56	72	56.25	78	60.94
$0.8 < TE \leq 1.0$	22	17.19	23	17.97	26	20.31	28	21.88	30	23.44	31	24.22	36	28.13	38	29.69
Total	128	100.00	128	100.00	128	100.00	128	100.00	128	100.00	128	100.00	128	100.00	128	100.00
Metal products																
$0.0 < TE \leq 0.2$	8	6.90	1	0.86	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
$0.2 < TE \leq 0.4$	45	38.79	21	18.10	9	7.76	2	1.72	0	0.00	0	0.00	0	0.00	0	0.00
$0.4 < TE \leq 0.6$	35	30.17	57	49.14	54	46.55	29	25.00	14	12.07	7	6.03	1	0.86	0	0.00
$0.6 < TE \leq 0.8$	17	14.66	21	18.10	36	31.03	61	52.59	68	58.62	65	56.03	48	41.38	19	16.38
$0.8 < TE \leq 1.0$	11	9.48	16	13.79	17	14.66	24	20.69	34	29.31	44	37.93	67	57.76	97	83.62
Total	116	100.00	116	100.00	116	100.00	116	100.00	116	100.00	116	100.00	116	100.00	116	100.00

Note: r.f = relative frequency.

Table 4. Average Technical Efficiencies by size

	Food			Textile		
Size	Small	Medium	Large	Small	Medium	Large
1993	0.43199	0.41966	0.34986	0.44008	0.52654	0.57842
1994	0.45637	0.44420	0.37445	0.44561	0.53158	0.58326
1995	0.48062	0.46869	0.39933	0.45113	0.53660	0.58807
1996	0.50466	0.49302	0.42435	0.45664	0.54160	0.59285
1997	0.52837	0.51706	0.44937	0.46214	0.54658	0.59761
1998	0.55167	0.54072	0.47428	0.46763	0.55153	0.60233
1999	0.57447	0.56392	0.49894	0.47310	0.55647	0.60703
2000	0.59669	0.58657	0.52325	0.47856	0.56139	0.61169
Average	0.51561	0.50423	0.43673	0.45936	0.54404	0.59516
	Chemical			Metal Products		
Size	Small	Medium	Large	Small	Medium	Large
1993	0.59472	0.65433	0.76630	0.45680	0.45306	0.54451
1994	0.61458	0.67182	0.77885	0.52955	0.53068	0.61416
1995	0.63387	0.68874	0.79090	0.59924	0.60344	0.67768
1996	0.65256	0.70507	0.80246	0.66353	0.66937	0.73390
1997	0.67063	0.72081	0.81351	0.72101	0.72744	0.78247
1998	0.68806	0.73595	0.82408	0.77108	0.77743	0.82360
1999	0.70484	0.75047	0.83416	0.81379	0.81966	0.85789
2000	0.72096	0.76438	0.84376	0.84961	0.85481	0.88613
Average	0.66003	0.71145	0.80675	0.67558	0.67949	0.74004

Note: Small firms: Output less then 500 billion rupiah,
Medium firms: Output is between 50 billion and 100 billion rupiah,
Large firms: Output is more than 100 billion rupiah

Table 5. Average technical efficiencies by region and ownership

	Food		Textile		Chemical		Metal Products	
Region	East	West	East	West	East	West	East	West
1993	0.42108	0.42412	0.51272	0.45579	0.64657	0.62356	0.52202	0.46940
1994	0.44416	0.44860	0.51783	0.46124	0.66391	0.64225	0.59162	0.54275
1995	0.46737	0.47299	0.52293	0.46668	0.68076	0.66038	0.65633	0.61216
1996	0.49058	0.49718	0.52801	0.47210	0.69709	0.67791	0.71452	0.67557
1997	0.51367	0.52107	0.53307	0.47752	0.71288	0.69484	0.76543	0.73180
1998	0.53654	0.54457	0.53811	0.48291	0.72810	0.71115	0.80899	0.78049
1999	0.55907	0.56758	0.54313	0.48830	0.74275	0.72683	0.84560	0.82180
2000	0.58118	0.59004	0.54813	0.49366	0.75682	0.74187	0.87594	0.85631
Average	0.50171	0.50827	0.53049	0.47478	0.70361	0.68485	0.72256	0.68629
	Food		Textile		Chemical		Metal Products	
Ownership	Public	Private	Public	Private	Public	Private	Public	Private
1993	0.39441	0.43717	0.44594	0.46342	0.61644	0.63082	0.45927	0.48097
1994	0.41900	0.46151	0.45136	0.46885	0.63526	0.64925	0.53426	0.55300
1995	0.44355	0.48574	0.45677	0.47426	0.65353	0.66711	0.60501	0.62116
1996	0.46801	0.50973	0.46216	0.47966	0.67123	0.68440	0.66953	0.68336
1997	0.49229	0.53340	0.46755	0.48504	0.68833	0.70107	0.72673	0.73846
1998	0.51628	0.55663	0.47293	0.49042	0.70483	0.71712	0.77624	0.78609
1999	0.53985	0.57936	0.47829	0.49577	0.72070	0.73255	0.81829	0.82647
2000	0.56293	0.60151	0.48364	0.50111	0.73594	0.74734	0.85342	0.86016
Average	0.47954	0.52063	0.46483	0.48232	0.67828	0.69121	0.68034	0.69371

Table 6. Average technical efficiencies by age

Age (Year)	1993	1994	1995	1996	1997	1998	1999	2000	Average
					Food				
< 15	0.42772	0.45257	0.49143	0.50562	0.53440	0.55276	0.56628	0.58567	0.49980
15 – 30	0.43747	0.45553	0.46178	0.49255	0.51609	0.54454	0.57267	0.59587	0.51835
30 – 45	0.39564	0.43550	0.47991	0.52501	0.53964	0.56214	0.58209	0.60742	0.51443
> 45	0.38369	0.40867	0.43676	0.45580	0.48071	0.50287	0.53576	0.55436	0.48326
					Textile				
< 15	0.45884	0.46343	0.46617	0.46709	0.47235	0.47939	0.48308	0.48741	0.47031
15 – 30	0.46610	0.46838	0.47761	0.48988	0.49018	0.49288	0.49838	0.50447	0.48878
30 – 45	0.54649	0.66878	0.67301	0.56279	0.57283	0.54338	0.54808	0.51455	0.55705
> 45	0.29829	0.30405	0.30983	0.31563	0.40361	0.40925	0.41489	0.42053	0.37002
					Chemical				
< 15	0.65378	0.67689	0.69434	0.71486	0.73469	0.74838	0.77985	0.79002	0.71101
15 – 30	0.61808	0.63522	0.66043	0.67921	0.69529	0.71223	0.72310	0.74296	0.68699
30 – 45	0.52517	0.55691	0.56144	0.57661	0.59781	0.63214	0.68355	0.70958	0.62181
> 45	0.49536	0.51926	0.54260	0.56532	0.58738	0.60874	0.62937	0.64925	0.57466
					Metal Products				
< 15	0.46665	0.54258	0.61121	0.67841	0.72527	0.76955	0.80212	0.85516	0.65143
15 – 30	0.49365	0.55910	0.62729	0.68631	0.74665	0.79427	0.83402	0.85966	0.71730
30 – 45	0.34975	0.43622	0.51978	0.61935	0.68028	0.73880	0.82779	0.86061	0.63663
> 45	–	–	–	0.48943	0.64013	0.70365	0.75827	0.80436	0.70025

Table 7: Estimates and standard errors of regression coefficients

Variable	Estimates	Std. error	Estimates	Std. error
	Food		Textile	
Intercept	0.4574**	0.0287	0.4104**	0.2324
Size	-0.0018	0.0055	-0.0727**	0.0049
Region	-0.0031	0.0186	0.0532**	0.0136
Ownership	0.0448**	0.0089	-0.0059	0.0091
Age	0.0019	0.0070	0.0080	0.0067
	Chemical		Metal Products	
Intercept	0.1055**	0.0326	0.4845**	0.0455
Size	-0.0505**	0.0092	-0.0498**	0.0702
Region	0.0179	0.0151	0.0131	0.0223
Ownership	-0.0624**	0.0088	-0.0288*	0.0127
Age	0.0591**	0.0050	-0.0751**	0.0138

Note: the dependent variable in all these regression is inefficiency
* /**significant at 5%/1 % level of significance.

Table 8: Total factor productivity growths and its component

Year	Food				Textile			
	$\dot{TFP}$	TP	SC	$\dot{TE}$	$\dot{TFP}$	TP	SC	$\dot{TE}$
1994	-0.0459	-0.1111	-0.0021	0.0673	0.0320	0.0286	-0.0101	0.0135
1995	-0.0374	-0.0961	-0.0038	0.0624	0.0243	0.0212	-0.0101	0.0132
1996	-0.0352	-0.0823	-0.0108	0.0579	0.0119	0.0135	-0.0146	0.0130
1997	-0.0229	-0.0681	-0.0084	0.0536	0.0044	0.0062	-0.0146	0.0128
1998	-0.0094	-0.0533	-0.0058	0.0497	-0.0018	-0.0021	-0.0123	0.0126
1999	-0.0410	-0.0427	-0.0443	0.0461	-0.0623	-0.0079	-0.0668	0.0124
2000	0.0007	-0.0284	-0.0137	0.0427	-0.0267	-0.0160	-0.0229	0.0122
Average								
1994-2000	-0.0273	-0.0689	-0.0127	0.0542	-0.0026	0.0062	-0.0216	0.0128
1994-1997	-0.0353	-0.0894	-0.0063	0.0603	0.0181	0.0174	-0.0123	0.0131
1998-2000	-0.0166	-0.0415	-0.0213	0.0462	-0.0302	-0.0087	-0.0340	0.0124

Year	Chemical				Metal Products			
	$\dot{TFP}$	TP	SC	$\dot{TE}$	$\dot{TFP}$	TP	SC	$\dot{TE}$
1994	0.0227	-0.0134	0.0034	0.0326	0.0074	-0.1308	-0.0228	0.1610
1995	0.0158	-0.0166	0.0019	0.0304	-0.0071	-0.1150	-0.0187	0.1266
1996	0.0106	-0.0200	0.0022	0.0284	-0.0236	-0.1000	-0.0232	0.0996
1997	-0.0005	-0.0237	-0.0033	0.0265	-0.0209	-0.0852	-0.0140	0.0783
1998	0.0001	-0.0276	0.0029	0.0247	-0.0140	-0.0701	-0.0054	0.0615
1999	-0.0033	-0.0290	0.0027	0.0231	-0.0471	-0.0543	-0.0411	0.0483
2000	-0.0106	-0.0321	0.0000	0.0215	-0.0103	-0.0394	-0.0089	0.0380
Average								
1994-2000	0.0050	-0.0232	0.0014	0.0267	-0.0165	-0.0850	-0.0191	0.0876
1994-1997	0.0121	-0.0184	0.0011	0.0295	-0.0110	-0.1077	-0.0197	0.1164
1998-2000	-0.0046	-0.0296	0.0019	0.0231	-0.0238	-0.0546	-0.0185	0.0493

Table 9: Frequency Distribution of TFP growth

Class	1994		1995		1996		1997		1998		1999		2000	
	Freq.	r.f.	Freq.	r.f.	Freq.	r.f.	Freq.	%	Freq.	r.f.	Freq.	r.f.	Freq.	r.f.
Food														
-0.15 < TFPG ≤ -0.10	16	6.18	13	5.02	13	5.02	4	1.54	5	1.93	21	8.11	0	0.00
-0.10 < TFPG ≤ -0.05	105	40.54	75	28.96	73	28.19	56	21.62	40	15.44	59	22.78	15	5.79
-0.05 < TFPG ≤ 0.00	116	44.79	139	53.67	136	52.51	139	53.67	106	40.93	137	52.90	118	45.56
0.00 < TFPG ≤ 0.05	19	7.34	26	10.04	31	11.97	48	18.53	81	31.27	35	13.51	102	39.38
0.05 < TFPG ≤ 0.10	2	0.77	3	1.16	5	1.93	12	4.63	18	6.95	1	0.39	24	9.27
0.10 < TFPG ≤ 0.15	0	0.00	2	0.77	1	0.39	0	0.00	6	2.32	0	0.00	0	0.00
Textile														
-0.15 < TFPG ≤ -0.10	2	0.87	5	2.17	4	1.74	7	3.04	7	3.04	19	8.26	8	3.48
-0.10 < TFPG ≤ -0.05	12	5.22	13	5.65	10	4.35	11	4.78	18	7.83	52	22.61	37	16.09
-0.05 < TFPG ≤ 0.00	35	15.22	38	16.52	54	23.48	78	33.91	73	31.74	108	46.96	120	52.17
0.00 < TFPG ≤ 0.05	100	43.48	116	50.43	123	53.48	103	44.78	90	39.13	18	7.83	60	26.09
0.05 < TFPG ≤ 0.10	68	29.57	54	23.48	35	15.22	25	10.87	32	13.91	2	0.87	0	0.00
0.10 < TFPG ≤ 0.15	13	5.65	4	1.74	1	0.43	4	1.74	4	1.74	0	0.00	0	0.00
Chemical														
-0.15 < TFPG ≤ -0.10	0	0.00	0	0.00	1	0.78	1	0.78	1	0.78	2	1.56	0	0.00
-0.10 < TFPG ≤ -0.05	0	0.00	1	0.78	1	0.78	3	2.34	3	2.34	8	6.25	4	3.13
-0.05 < TFPG ≤ 0.00	26	20.31	41	32.03	45	35.16	55	42.97	61	47.66	57	44.53	80	62.50
0.00 < TFPG ≤ 0.05	78	60.94	67	52.34	72	56.25	63	49.22	54	42.19	51	39.84	44	34.38
0.05 < TFPG ≤ 0.10	24	18.75	19	14.84	9	7.03	5	3.91	8	6.25	8	6.25	0	0.00
0.10 < TFPG ≤ 0.15	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Metal products														
-0.15 < TFPG ≤ -0.10	10	8.62	10	8.62	10	8.62	5	4.31	3	2.59	14	12.07	2	1.72
-0.10 < TFPG ≤ -0.05	18	15.52	22	18.97	20	17.24	19	16.38	22	18.97	24	20.69	7	6.03
-0.05 < TFPG ≤ 0.00	20	17.24	22	18.97	39	33.62	50	43.10	50	43.10	50	43.10	64	55.17
0.00 < TFPG ≤ 0.05	32	27.59	35	30.17	31	26.72	28	24.14	33	28.45	16	13.79	39	33.62
0.05 < TFPG ≤ 0.10	19	16.38	11	9.48	8	6.90	8	6.90	6	5.17	5	4.31	4	3.45
0.10 < TFPG ≤ 0.15	7	6.03	6	5.17	5	4.31	3	2.59	1	0.86	0	0.00	0	0.00

Note: r.f = relative frequency.

The TFPG below –0.15 and above 0.15 are not reported, since the numbers of firms are

Table 10. Total factor productivity growths by size
(1994-2000)

Size	Food			Textile		
	Small	Medium	Large	Small	Medium	Large
1994	-0.0405	-0.0710	-0.0730	0.0346	0.0281	0.0078
1995	-0.0326	-0.0562	-0.0661	0.0269	0.0108	0.0183
1996	-0.0308	-0.0551	-0.0584	0.0137	0.0094	-0.0054
1997	-0.0182	-0.0464	-0.0451	0.0005	0.0145	0.0325
1998	-0.0034	-0.0369	-0.0408	0.0032	-0.0071	-0.0524
1999	-0.0409	-0.0416	-0.0408	-0.0575	-0.0865	-0.0754
2000	0.0056	-0.0199	-0.0268	-0.0222	-0.0396	-0.0567
Average	-0.0230	-0.0467	-0.0501	-0.0001	-0.0101	-0.0187
	Chemical			Metal Products		
	Small	Medium	Large	Small	Medium	Large
1994	0.0239	0.0222	0.0161	0.0230	-0.0146	-0.0197
1995	0.0151	0.0227	0.0092	0.0030	0.0017	-0.0466
1996	0.0098	0.0141	0.0102	-0.0157	-0.0287	-0.0430
1997	-0.0031	0.0082	0.0013	-0.0149	-0.0399	-0.0215
1998	-0.0015	0.0077	-0.0022	-0.0101	-0.0150	-0.0249
1999	-0.0069	0.0099	-0.0019	-0.0498	-0.0364	-0.0490
2000	-0.0128	-0.0022	-0.0105	-0.0083	-0.0156	-0.0115
Average	0.0035	0.0118	0.0032	-0.0104	-0.0212	-0.0309

Table 11. Total factor productivity by region and ownership

	Food		Textile		Chemical		Metal Products	
Region	East	West	East	West	East	West	East	West
1994	-0.0403	-0.0461	0.0303	0.0322	0.0216	0.0228	-0.0138	0.0092
1995	-0.0352	-0.0376	0.0210	0.0246	0.0241	0.0150	-0.0120	-0.0066
1996	-0.0404	-0.0349	0.0101	0.0121	0.0045	0.0112	-0.0142	-0.0244
1997	-0.0424	-0.0218	0.0060	0.0042	-0.0008	-0.0005	-0.0154	-0.0214
1998	-0.0219	-0.0087	-0.0159	-0.0006	-0.0036	0.0004	-0.0400	-0.0118
1999	-0.0346	-0.0413	-0.0580	-0.0627	-0.0068	-0.0030	-0.0576	-0.0462
2000	0.0156	-0.0001	-0.0182	-0.0273	-0.0089	-0.0108	-0.0171	-0.0097
Average	-0.0285	-0.0272	-0.0035	-0.0025	0.0043	0.0050	-0.0243	-0.0158
Ownership	Public	Private	Public	Private	Public	Private	Public	Private
1994	-0.0456	-0.0459	0.0390	0.0303	0.0221	0.0231	0.0157	0.0031
1995	-0.0321	-0.0398	0.0178	0.0259	0.0192	0.0138	0.0052	-0.0135
1996	-0.0338	-0.0358	0.0123	0.0118	0.0083	0.0120	-0.0324	-0.0189
1997	-0.0261	-0.0214	0.0166	0.0014	0.0031	-0.0026	-0.0131	-0.0250
1998	-0.0102	-0.0090	-0.0261	0.0042	0.0001	0.0001	-0.0118	-0.0151
1999	-0.0384	-0.0421	-0.0628	-0.0622	-0.0090	0.0000	-0.0405	-0.0506
2000	-0.0022	0.0019	-0.0396	-0.0235	-0.0065	-0.0130	-0.0072	-0.0120
Average	-0.0269	-0.0275	-0.0061	-0.0017	0.0053	0.0048	-0.0120	-0.0189

Table 12: Elasticities of Output with respects to
Capital, Labor and Material

Sector	Size	e_k	e_l	e_m	e
Food	Small	0.40278	0.10773	0.38604	0.89655
	Medium	0.36791	0.12721	0.47838	0.97350
	Large	0.34507	0.13047	0.55231	1.02785
	All	0.39492	0.11131	0.40801	0.91424
Textile	Small	0.53360	0.19660	0.13684	0.86704
	Medium	0.63249	0.11066	0.13087	0.87403
	Large	0.66667	0.13139	0.12901	0.92708
	All	0.55474	0.18151	0.13558	0.87183
Chemical	Small	0.78245	0.17452	0.11977	1.07675
	Medium	0.69670	0.18958	0.14463	1.03092
	Large	0.64389	0.15296	0.19978	0.99663
	All	0.75080	0.17470	0.13362	1.05912
Metal Products	Small	0.51619	0.25153	0.13039	0.89811
	Medium	0.60188	0.21157	0.12344	0.93689
	Large	0.62619	0.19538	0.13424	0.95581
	All	0.55425	0.23282	0.12983	0.91690

Note: $e = e_k + e_l + e_m$